



# Fixing Holiday Lights

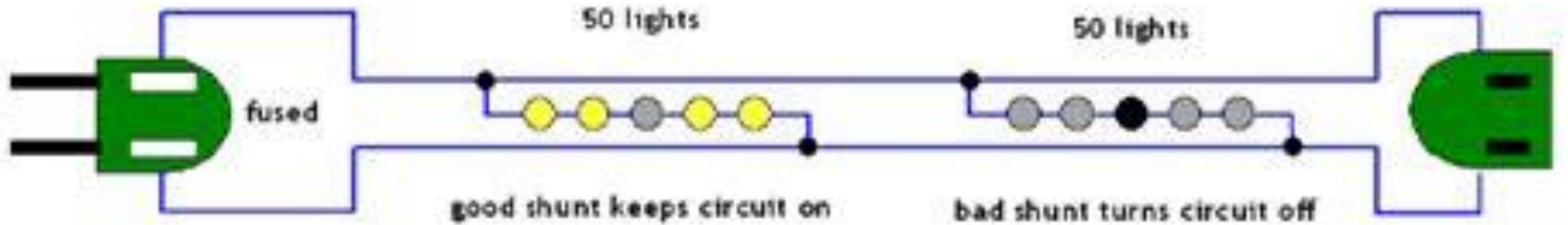
When Good Lights Go Bad



# Basic Facts of Holiday Light Strings

- A string has many small bulbs.
- Each bulb needs only a low voltage: ~2.5 volts.
- About 50 are linked in a series to match the line voltage of 125 volts.
- A string may have two or more separate series/sections.
- Sections start and end with a socket with three wires.
- If one bulb in a series burns out then the entire series may go dark.
- Replacing a burned out bulb may restore the entire series.
- Some light strings have fuses in the plug that may cause the entire string to go out.
- Strings have plugs at both ends and can be connected together.

# Light String Schematic



# Incandescent versus LED strings

- Incandescent
  - Old style bulbs with filaments – often burn out.
  - Replaceable bulbs.
  - Generally fused to protect against circuit overload and shorts.
  - About 40 watts of power per string.
- LED (Light Emitting Diodes)
  - Solid state without filaments – long lasting.
  - Bulbs rarely replaceable.
  - Generally fused as well.
  - About 5 watts per string.

# Incandescent Mini Lights



# Troubleshooting Incandescent Strings

- **Make sure the string is unplugged when working on it !**
- If a single bulb is out but the others are on, replace it as it can cause others to burn out.
- If the entire string is out:
  - Check fuses (or just plug something into the far end).
  - Check wires.
  - Otherwise, it may have many burned out bulbs (see below).
- If a section is out, then one (or likely more bulbs) are not working
  - Make sure no bulbs are missing, broken or loose.
  - Identify burned out bulb with visual inspection of the filaments or with a voltage sensing device.
  - Remove bulb and socket, confirm, install new bulb into string.
  - Test and repeat as necessary. There may be many bulbs to replace!

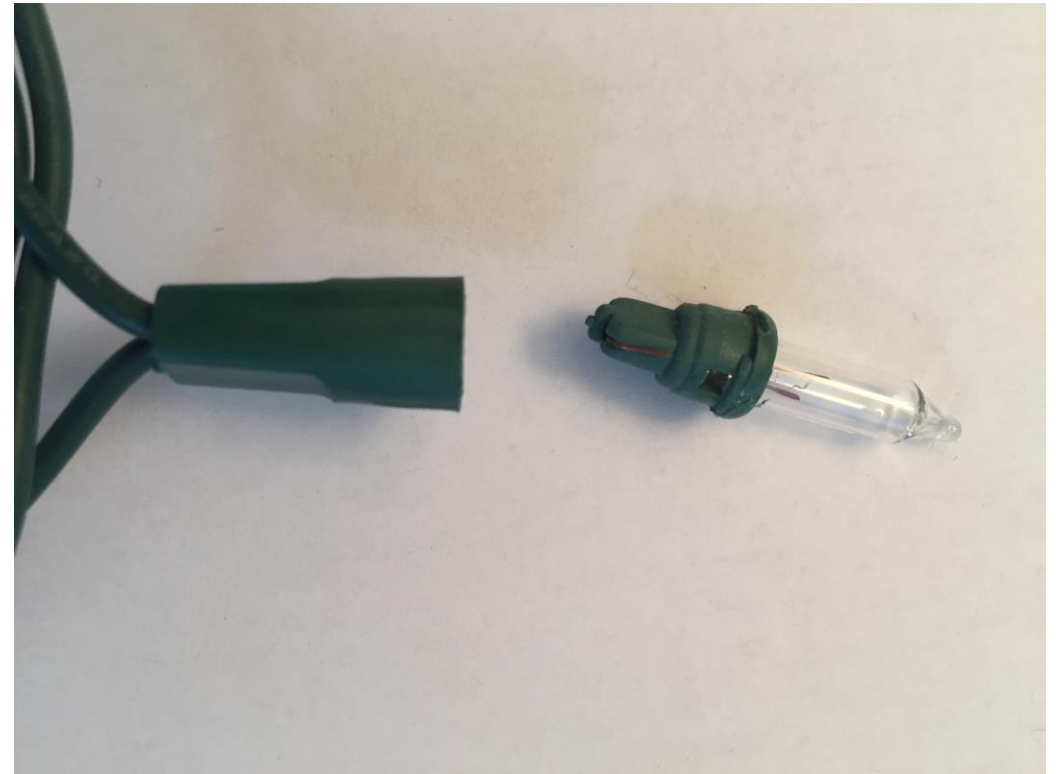


# Incandescent Socket and Bulb Detail

**In Place**



**Removed**





# Bulb Detail – Part 2

**Wires Unfolded**



**Bulb Removed**



# Incandescent Bulb Failure Modes

- Incandescent bulbs can fail in two ways:
  - 1 – The filament burns out, the **shunt closes** and the current keeps flowing. This is good because the other lights stay on, but it is bad because the current increases and the other bulbs are more likely to fail now.
  - 2 – The filament burns out, but the **shunt does not close** and the current stops flowing. This is good because it protects the other bulbs, but it is bad because the entire series is now dark.
- Total Series Failure
  - When an entire series fails it is likely that multiple bulbs have burnt out, but that only one has an open shunt. Many bulbs may be bad in that case. We did a sample test of a 10 bulb section and found 4 that were burned out (40%). One needs ask whether it worth testing and replacing that many bulbs?

# Light Keeper Pro – Quick Fix

- Since a dark section has a burned out bulb whose shunt did not close, it may be possible to close that shunt using the tool Quick Fix option.
- This is done when the string is plugged in with power on, so be careful and follow the instructions.
- If successful, the shunt will close and bulbs in that section will light up.
- However, there will likely be many burned out bulbs.
- Note them, unplug the string, and then replace them all. (This can be a lot of bulbs – I had to replace 14 out of a 35 bulb section.)
- Not all bulbs are equal: some are for 50 and others for 35 bulb series.
- If not replaced, the section will likely overload and burn out more bulbs and fail again.

# Using a String Voltage Tester

- Using a non-contact voltage tester one can sometimes find the burned out bulb with an open shunt. Replacing that bulb may close the circuit and cause the current to flow again.
- Light Keeper Instructional Videos
  - <https://lightkeeperpro.com/instructional-videos/>
- While it's possible to fix a burned-out string, that is often a lot of work. Prevention is the best approach.

# Incandescent Light String Maintenance

- **Immediately replace burned out bulbs !**
  - Some bulbs when they burn out close a shunt that keeps the rest of the section on.
  - However, that increases the voltage and current in the remaining bulbs increasing the chance that they too will burn out.
  - That can escalate to a section with many burned out bulbs which eventually goes dark and is a real nuisance to repair as many bulbs must be replaced.
- Physically and electrically check the string before goes up and before it's put away.
- Check weekly for burned out bulbs and replace them. Multiple failures can lead to total failure.

# LED Mini Lights



# LED (Light Emitting Diodes) Mini Lights

- Look very much like incandescent – but the bulbs are often glued in and are not meant to be replaced. They are very reliable.
- An LED light uses  $\sim 2.5\text{-}3.5$  volts so they are connected in series of 35-50 lights.
- If one light fails, the entire series goes out.
- However, failure of multiple lights in a series is uncommon.
- Causes of failure could be a bad LED or a bad connection.



# Using a LED String Testing Device

- LED Light Keeper Tool videos:
  - <https://www.ledkeeper.com/4-minute-demonstration-videos/>
- You can replace a bad LED socket with another by splicing and soldering.
  - However, since LEDs are “diodes” and only allow current to flow in one direction, any replacement LED needs to have the same alignment as the others.
  - You can also just cut it out altogether and splice and solder the wires together. That has a small risk of stressing the remaining LEDs more.
- You can also cut up an old string for spare parts.

# Power Consumption Comparison

- Typical Use – 8 hours per day for 60 days.
- Electricity cost \$0.15 / kWh
- **Incandescent** – 40 watts/string
  - Uses 19.2 kWh = \$2.88
- **LED** – 5 watts/string
  - Uses 2.4 kWh = \$0.36
  - About 1/8 the energy of the old-style incandescent lights.
  - Much more reliable too.

# More Resources

- Light Keeper Pro: <https://lightkeeperpro.com/instructional-videos/>
- LED Light Keeper: <https://www.ledkeeper.com/4-minute-demonstration-videos/>
- Light Sets A-Z: <https://vimeo.com/291771349>
- Fix-it books from the local library
- Fix-It clinics: <https://fixitclinic.blogspot.com/>; <https://www.facebook.com/FixitClinic>
- Recycle Arlington: <https://www.arlingtonma.gov/departments/public-works/recycling-trash-composting>
- Other ...
  
- Version: 2/26/21

# Final Takeaway

- Regular maintenance is much better than neglect and heroic repair.
- A fix in time saves nine!

Power load increases with voltage as bulbs shunt out.

